PATENT SPECIFICATION

Application Date. *Feb. 7, 1924*. *No. 3234/24*. **233,423**

Complete Accepted: May 7, 1925.

COMPLETE SPECIFICATION.

Improvements in or relating to Rotary Pumps or the like.

We, THE HILL COMPRESSOR & PUMP CO., INC., a corporation organised and existing under the laws of the State of Delaware and the head office of the company is 1417, Grand Central Terminal Building, in the City, County and State of New York, EBENEZER HILL, a citizen of the United States of America, now residing at 138E, 47th Street, in the City, County and State of New York, whose official domicile is in the City of South Norwalk, County of Fairfield, State of Connecticut, and HARRY DARWIN EDWARDS, a citizen of the United States of America, of 55, Sinebrook Drive, Larchmont, Westchester County, State of New York, all in the United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention is for improvements in rotary pumps, compressors, and the like hereinafter termed "pumps", which comprise a casing having intake and discharge openings, and an outer gear, internally toothed, and an inner gear, externally toothed, in mesh and eccentrically arranged with relation to each other, and the outer gear being of greater diameter, and having a greater number of teeth by one, than the inner gear, whereby chambers, progressively increasing in capacity from the bottoming contact point to the crest contact point, and progressively decreasing in capacity from the crest contact point to the bottoming contact point of the gears are provided.

It has been proposed previously to construct a rotary engine pump meter or blower of this type "wherein both inner and outer wheels have teeth which are formed as true cycloids shaped by a rolling circle having a diameter intermediate of the diameters of the pitch circles of the inner and outer wheels (preferably the arithmetic mean or approximate thereto of such diameters)" and in that case it was stated that "the face of an internal tooth (on the outer wheel) is shaped to a complete hypocycloid", "the face of the teeth on the (other) wheel is shaped to a complete epicycloid" and "the flanks of the teeth . . . are shaped to fit the faces".

Also, a rotary air compressor of this type has been previously claimed in which "an annular toothed rotor may be provided with lobes having for their convex portions cycloidal curves and a pinion rotor having one less tooth or lobe with the lobes and spaces provided with cycloidal curves to fit the lobes of the annular rotor as they rotate together".

"The curves of the teeth or lobes are formed in such a manner (in general well known to those skilled in the art) that they engage each other continuously during rotation to separate the tooth spaces".

Further it has been previously claimed in a rotary engine or pump of this type to provide teeth "having contours which maintain simultaneously a plurality of fluid tight engagements between them" and in this case it was stated that "the driving contacts are preferably flatter than cycloids whose radii of curvature reduce to zero at their ends".

In accordance with the present invention, both the inner and outer gears have the engaging surfaces of the teeth of each gear formed on continuous and complete epicycloidal and hypocycloidal curves joined together at their respective pitch lines and formed by rolling along the pitch circles of the respective gears, a generating circle, the diameter of which is equal to the eccentricity of the gears when assembled.

The invention also provides for rapid

influx to the intake chambers, or those chambers progressively increasing in capacity from the bottoming point to the crest contact point. This is accomplished according to this invention by chamfering the edges on the front or advance side of the teeth of the inner gear or the edges on the reverse or following side of the teeth of the outer gear whereby the cavities may be connected to form one long chamber on the intake side of the pump without altering the shapes of the effective engaging and sealing faces, or affecting the driving contact of the teeth or the sealing engagement of the teeth on the compression side.

The invention further provides for the correct eccentric adjustment of the gears in order to ensure the proper correlation and co-operation of the gear teeth and the efficient action of the pump.

Correct eccentric adjustment of the gears is essential to the efficiency of the pump, and a simple method of accomplishing this adjustment in accordance with this invention is to mount the inner gear on an arbor having a support, which may be a spindle, with the axis of the arbor eccentric to the axis of the spindle and both axes eccentric to the axis of the outer gear.

In the accompanying drawings:

Figure 1 shows a central longitudinal section of a pump constructed according to the invention.

Figure 2 shows a face view of the pump on line 2—2 of Figure 1 with the head removed.

Fig. 3 shows a face view, on a larger scale, of the inner and outer gears and illustrates diagrammatically the shapes of the engaging teeth, the eccentricity of the gears, and the method employed in generating the epicycloidal and hypocycloidal curves of the teeth.

Fig. 4 shows the leading faces of the inner gear chamfered to connect the cavities on the intake side of the pump.

Fig. 5 shows the back faces of the teeth of the outer gear chamfered so that the spaces on the intake side are connected into one continuous space.

Fig. 6 shows diagrammatically in full lines the pitch circles of the gear teeth, as when the eccentricity of the gears is correct, and in dotted lines the pitch circle of the inner gear when improperly adjusted to the pitch circle of the outer gear.

Like numerals of reference indicate like parts throughout the specification and drawings.

The casing 1 which is generally circular in outline contains a cylindrical pumping chamber 2 that is closed on one end by a head 3 fastened to the casing by any suitable means. The casing has an intake passage 4 on one side, and a discharge passage 5 on the other side, while the head has intake ports 6 leading from the intake passage 4 to the pumping chamber and a discharge port 7 leading from the pumping chamber to the discharge passage 5. Within the pumping chamber 2 is a rotor 8, the hub 9 of which is mounted on anti-friction bearings 10. The driving shaft 13 is splined in the hub of the rotor and fastened to the rotor is the outer gear 14. Engaging the teeth of this outer gear 14 are the teeth of the inner gear 15. The inner gear 15 is mounted on anti-friction bearings 16 that are supported by an arbor 11 forming part of a spindle 17 fastened in the head. The spindle 17 and arbor 11 are eccentric to each other and both positioned out of line with the driving shaft 13 so that the axis of the inner gear 15 will be eccentric to the axis of the outer gear 14. The outer gear 14 has more teeth than the inner gear 15 and when assembled and the eccentricity correctly adjusted, these gears will coact to effect the pumping or compression of fluids.

The outer gear 14 has internal teeth 314 (see Fig. 3) and its periphery is so shaped that there will be a close but rotatable fit with the cylindrical casing. The inner gear 15 has external teeth 315 and in Fig. 3 the inner gear is illustrated as having eight teeth and the outer gear as having 9 teeth, but the invention is not limited to this number of teeth in either gear.

The addendum sections 325 or the portions beyond the pitch circle 326 of the teeth of the inner gear are formed on epicycloidal curves, that is curves developed by a point on the circumference of the circle 327, rolled on the convex side of the pitch circle 326 of the inner gear. The dedendum sections 328 or the portions inside of the pitch circle 326 of the teeth of the inner gear are formed on hypocycloidal curves, that is, curves developed by a point on the circumference of the circle 327 rolled on the concave side of the pitch circle 326 of the inner gear. The addendum sections 329 of the teeth of the outer gear are formed on hypocycloidal curves, that is, curves developed by a point on the circumference of a circle 330 rolled on the concave side of the pitch circle 331 of the outer gear, while the dedendum sections 332 of the teeth of the outer gear are formed on epicycloidal curves, that is, curves developed by a point on the

circumference of a circle 330 rolled on the convex side of the pitch circle 331 of the outer gear. The circles 327 indicated as rolling on the convex and concave sides of the pitch circle 326 of the inner gear, and the circles 330 indicated as rolling on the convex and concave sides of the pitch circle 331 of the outer gear, for generating the epicycloidal and hypocycloidal curves, of the gear teeth, are the same in diameter, and the diameter of these circles is the same as the amount of eccentricity of the inner gear to the outer gear, as indicated by the circle 342 in Fig. 3.

As the gears rotate the capacities of the spaces increase between the teeth of the inner and outer gears from the point 333 on the common diameter of the wheels to the point 334 where the crests of the teeth engage, this being the intake or suction side of the pump; while the capacities of the spaces between the teeth from the point of crest engagement 334 to the bottoming point 333 decrease, this being the discharge or compression side of the pump. By virtue of this tooth contact, a close seal is made between the teeth of the gears and in the form described and illustrated in Fig. 3, each space, cavity or chamber has no communication with the other, on either the intake or discharge sides. This tight seal of the chambers or cavities is made on the intake side at the point 333 which is the bottoming point, at the points 350, 351 and 352 and crest contact point 334; and on the compression side at the points 353, 354 and 355, and at the crest contact point 334 and the bottoming point 333.

Fluid, owing to the progressive increase of the chambers or cavities on the intake side, enters the pump and is compressed on the compression side due to the progressive contraction of the spaces on this latter side. The degree to which the fluid can be compressed in pumps of fixed rated capacity depends on the distance on the compression side, of the discharge port from the crest contact point. The further around the discharge port is from the crest contact point and the nearer the discharge port is to the bottoming point, the greater is the compression, for the spaces between the teeth progressively decrease from the crest contact point to the bottoming point and the density of the fluid consequently is increased between these points until it escapes through the discharge port.

A lubricant may be introduced between the teeth of the inner and outer gears and with teeth of the form described there is space for the lubricant to remain in the cavities, including that cavity in which the pitch circles of the two gears are tangent, and this ensures a tight sealing of the joints between the cavities entirely around the gears.

With gear teeth of the shape described, the spaces are of maximum capacity, at the bottoming contact point friction is eliminated and operating power is economised; and the width of the teeth is such that the danger of breaking the seal and the escape of the fluid backward from one cavity to the following cavity across the side faces of the teeth is reduced to a minimum.

A pump having teeth of the form described is particularly serviceable for compressing light gases to a relatively high degree of density but for pumping liquids where compression is not required, only flow, where easier influx is desired the edges of the teeth of the front or advanced side of the inner gear may be chamfered as seen at 436 in Fig. 4, and the edges of the teeth on the reverse or following side of the outer gear may also be chamfered as seen at 537 in Fig. 5. This merely increases the capacity of the cavities on the compression side of the pump, but on the intake side, it connects the cavities and forms one long intake chamber without affecting the driving contact of the teeth or the sealing engagement of the teeth on the compression side.

In ordinary manufacture and particularly in quantity production it is difficult to obtain the exact or correct eccentricity of the gears which will result in the pitch circles being tangent so that the teeth will properly engage with a rolling and sealing contact. The spindle 17, as above stated, is eccentric to the axis of the driving shaft 13, and this spindle is provided with an arbor 11 that is eccentric to the spindle and also to the driving shaft. In order to obviate the necessity of exercising great skill and care in obtaining the required eccentricity of the gears, a way of accomplishing this adjustment is diagrammatically illustrated in Fig. 6 which shows the pitch circle 650 of the inner gear 15 first represented in full lines as having a proper eccentricity with relation to the pitch circle 640 of the outer gear 14, to ensure the necessary tangency, indicated by the line 660, of the pitch circles of the two gears to produce the desired results. In the same figure the pitch circle 650 of the inner gear 15 is represented in dotted lines as having an improper eccentricity with relation to the pitch circle.

In the diagrammatic view the point 626 is the axis of the outer gear, and the point 627 is the axis of the inner gear and also that of the arbor 11. The point 628 represents the axis of the spindle of the arbor which supports the inner gear. The radius of the circle 630 indicates the correct amount of eccentricity of the gears. In Fig. 6 the point 627 enclosed by a circle in full line, indicating the axis of the arbor must be always located on the circumference of the circle 630 when the pitch circle 650 is in correct eccentric relation with the pitch circle 640. In the same figure the point 627, enclosed by a circle in dotted lines, representing the arbor 11, is indicated in an accidental position, this being an incorrect eccentric relation of the pitch circle 650 shown by dotted line in Fig. 6 to the pitch circle 640. With the construction illustrated and the axis 627 of the arbor 11 in any accidental position, by rotating the spindle represented by a circle in full lines enclosing the point 628 indicating its axis, the arbor may be swung so as to bring the axis 627 which is also that of the inner gear, into the circle 630, or at such a distance from the point 626, the axis of the outer gear, that the gears will have the correct eccentricity and the pitch circles be tangent at the point 625, which is called the bottoming contact point.

The spindle may be provided with any convenient means for turning and adjusting it, and locked by any convenient means after the adjustment is made. This principle of construction allows any slight error in the eccentricity of the gears, such as is liable to occur in the manufacture of the pump, to be quickly corrected during the assembly of the parts, and this also permits any future adjustment of the gears to be made, if such should become necessary.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A rotary pump, compressor, or the like of the type described, in which both the inner and outer gears have the engaging surfaces of the teeth of each gear formed on continuous and complete epicycloidal and hypocycloidal curves joined together at their respective pitch lines, and formed by rolling along the pitch circles of the respective gears a generating circle the diameter of which is equal to the eccentricity of the gears when assembled.

2. A pump, compressor, or the like of the type described, and provided with teeth shaped as set forth in the preceding claiming clause in which the teeth of one or both of the said gears are shaped to form one continuous chamber on the intake side without affecting the driving contact of the teeth and the sealing of the teeth on the compression side.

3. A rotary pump, compressor, or the like as in Claim 1 or 2, in which the inner gear is mounted on an arbor having a support, with the axis of the arbor eccentric to the axis of the support, and both axes eccentric to the axis of the outer gear, whereby the eccentricity of the gears may be adjusted.

4. A pump, compressor, or the like substantially as described and illustrated in Figs. 1, 2 and 3 of the drawings.

5. A pump, compressor, or the like substantially as described and illustrated in Figs. 1, 2 and 4 of the drawings.

6. A pump, compressor, or the like substantially as described and illustrated in Figs. 1, 2 and 5 of the drawings.

Dated this 7th day of February, 1924.

BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London, E.C.,
Chartered Patent Agents.

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Fig. 1.

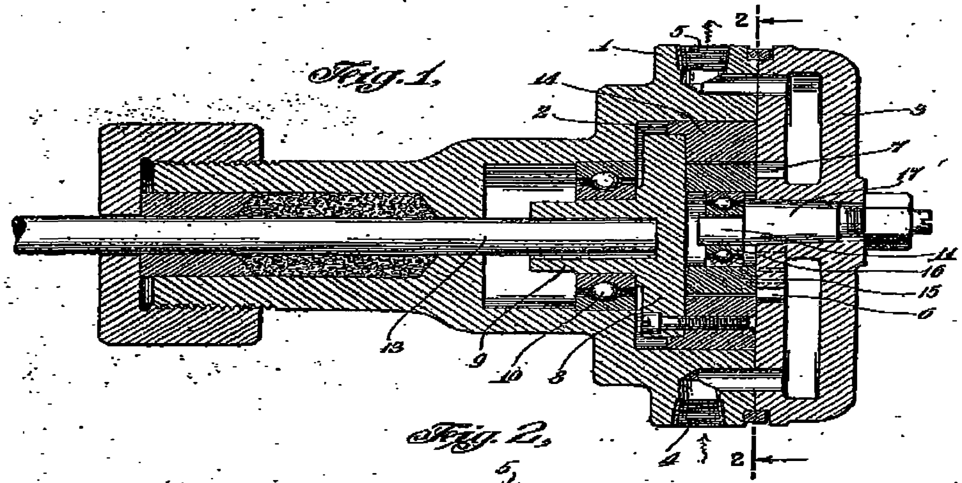
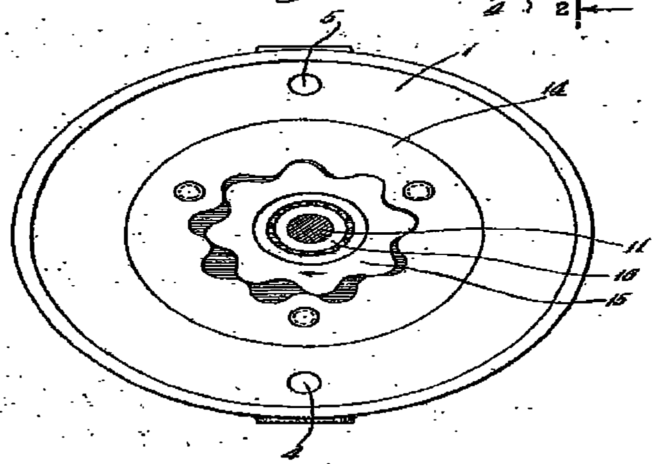
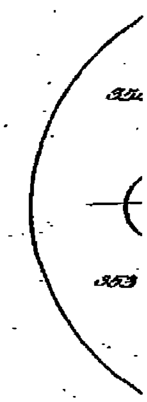


Fig. 2.





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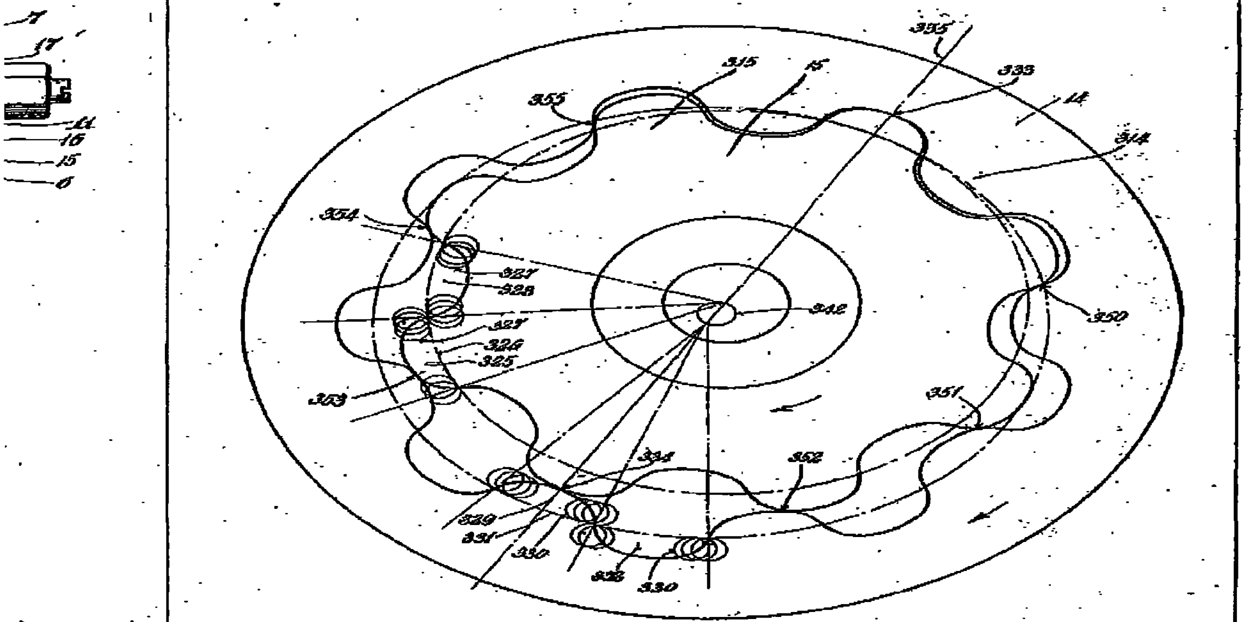
5 SHEETS

SHEET 1

SHEET 2

Fig. 3.



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523,453 COMPLETE SPECIFICATION

5 SHEETS

SHEET 1

Fig. 1,

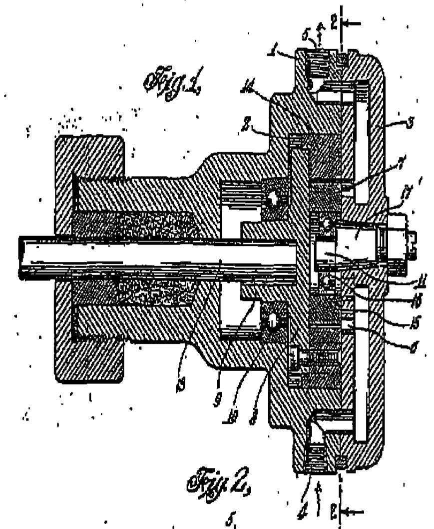
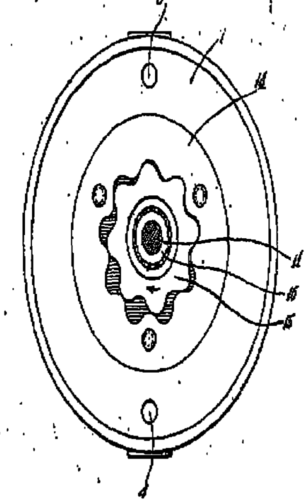


Fig. 2,



SHEET 3

Fig. 3,

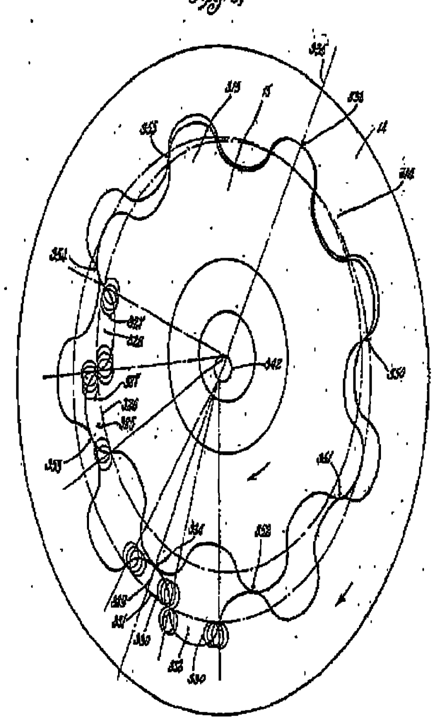


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Fig. 4.

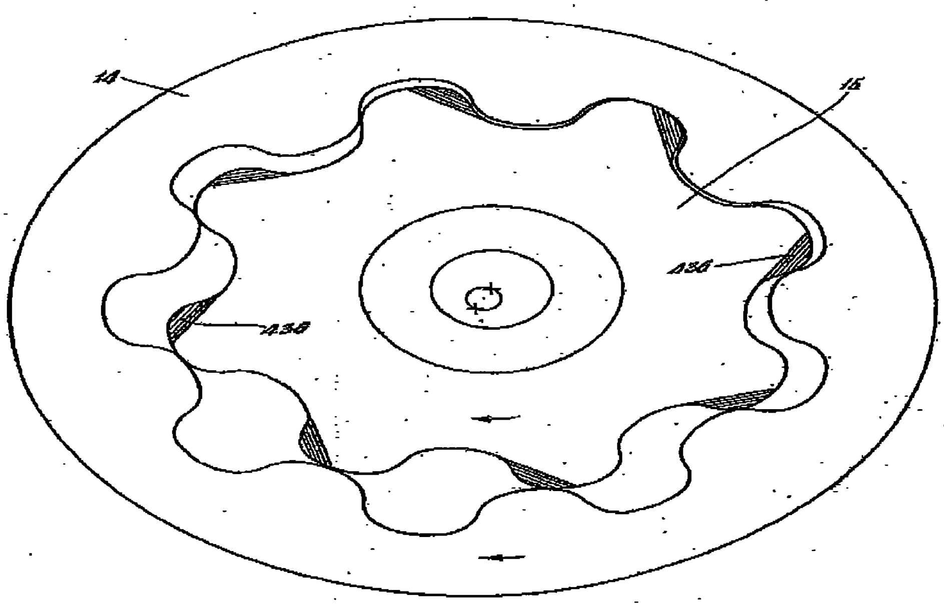
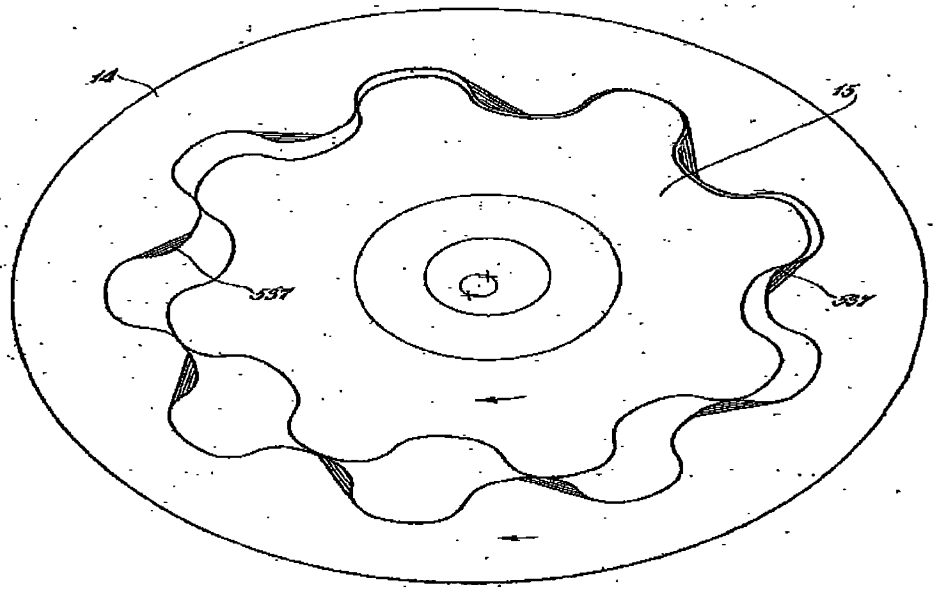
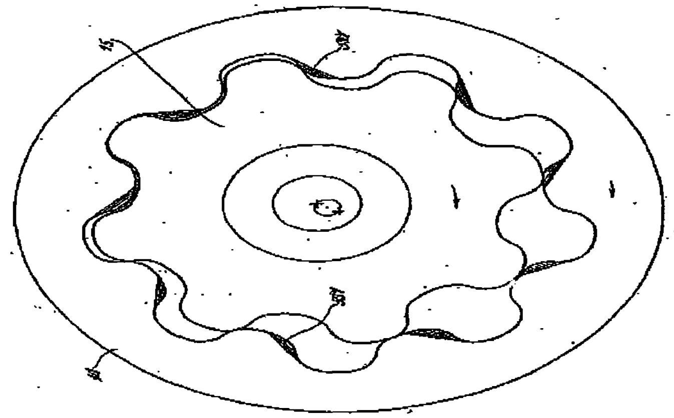


Fig. 5.



5 SHEETS SHEET 4

Fig. 5.



SHEET 3

Fig. 4.

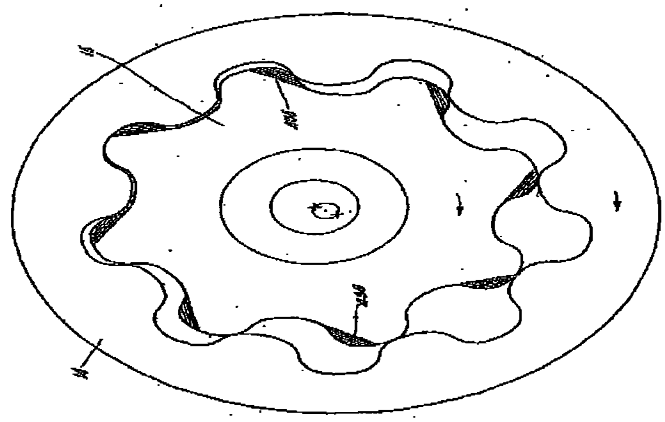


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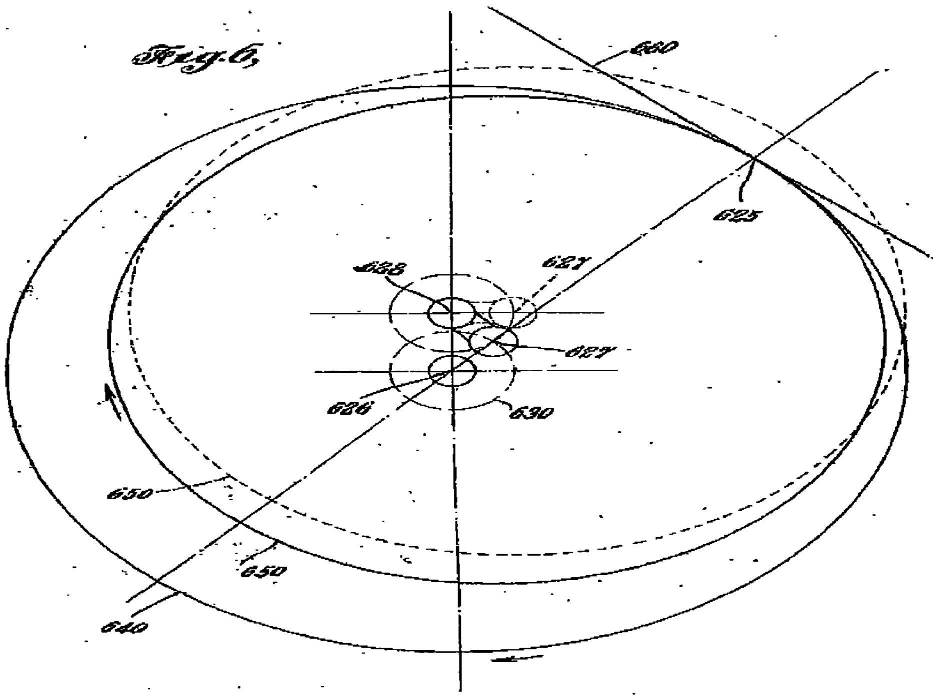
Fig. 6,



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